Developing a Plan of Action to Protect a Streambank

This pamphlet can be used to guide the landowner and local government in developing a plan of action to protect a distressed streambank. Such a plan of action has eight basic steps:

1. Determine why the streambank is in a distressed condition
2. Decide if the bank is worth protecting
3. Inventory available resources
4. Select a bank protection method
5. Develop a project plan
6. Obtain a permit
7. Construct the project
8. Inspect and maintain the project

Following this plan of action cannot guarantee that the progressive loss of a distressed streambank can be slowed or halted. However, by using an organized approach to deal with a bank erosion or failure problem, the chances of success will be improved and the possibility of a fruitless investment of time and money greatly reduced.

Step 1

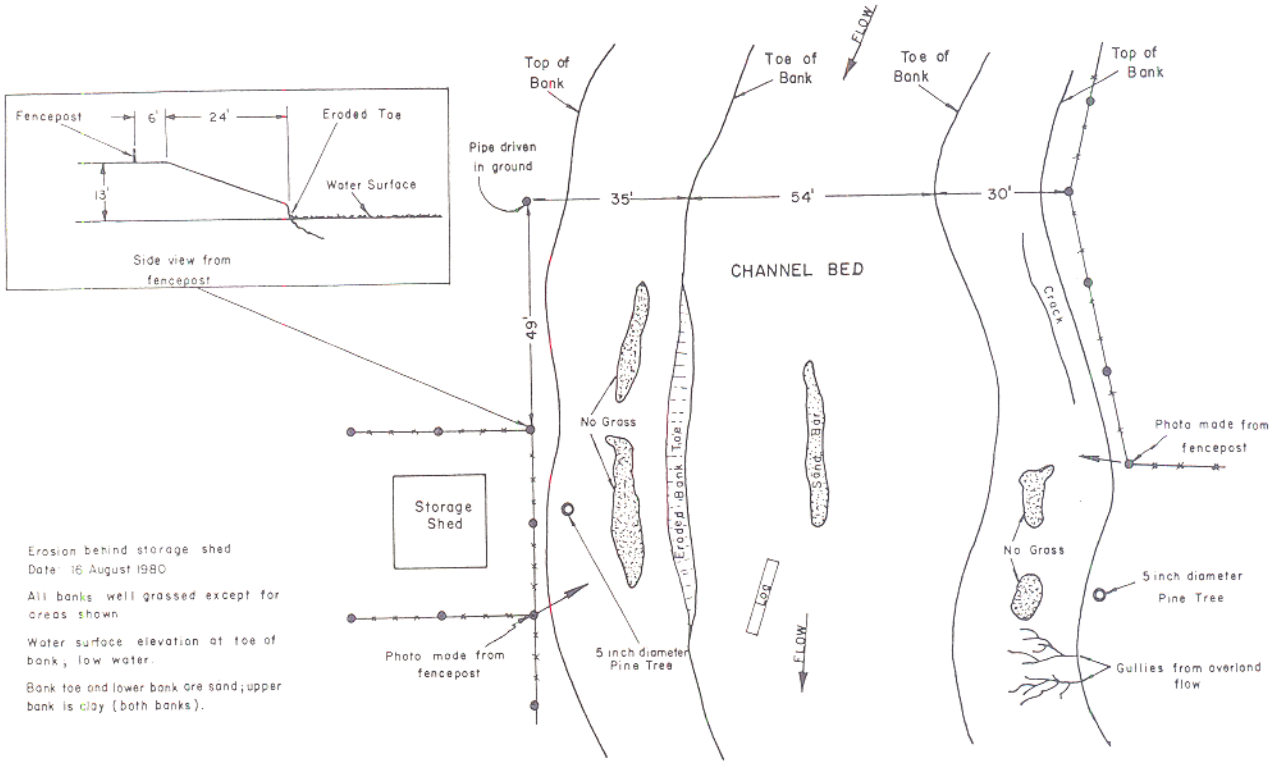
DETERMINE WHY THE STREAMBANK IS IN A DISTRESSED CONDITION

The search for clues to determine why a streambank is eroded or why it failed is often an after-the-fact investigation. In most instances healthy streambanks warrant only a passing glance. When a bank becomes distressed and public safety or loss of tangible assets becomes a factor, only then does the typical landowner or local government become concerned about the well being of the bank.

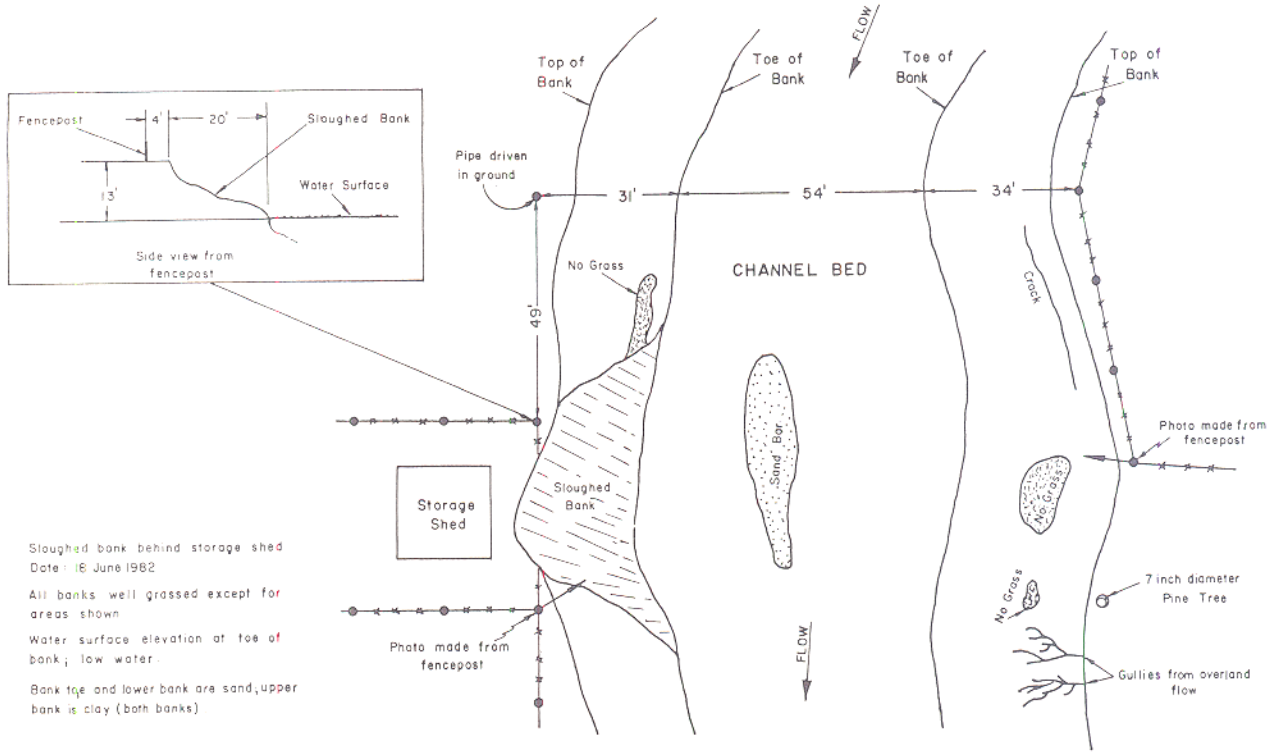
Many distressed streambank problems start during floods. Because of high water, direct observation of developing bank erosion or failure is often impossible. Only after the high water has receded can an attempt be made to determine why the bank eroded or failed. In many cases, the clues must come from inspecting a raw steep bank whose surface vegetation has been stripped away leaving only large trees leaning toward the stream with parts of their root masses exposed. What happened? Did flood flow scour out the toe leaving an unsupported bank... hard to tell if the bank sloughed off and covered up the eroded toe. Did the stream current erode the bank face back to a slope steeper than the bank could stand ... impossible to determine since the erosive action could not be watched. Did clay swelling in the bank due to floodwater inflow cause the bank to fail... a difficult problem to assess since clay swelling cannot be observed.

Obviously, these are cases where professional assistance is needed... but where does this leave the landowner or local government when aid is not available? The answer to this problem is to avoid trying to identify the cause(s) of streambank erosion or failure strictly on the basis of an after-the-fact investigation. Putting together a well-documented history of the development of a distressed bank cannot be based on a single inspection visit. Streambanks should be visited regularly to check for *warning flags* that may indicate troubles are ahead. Signs to look for are

—Exposed soil
—Loss of vegetation and fenceposts
—Sheet or rill erosion resulting from rainfall, overbank drainage, or seepage
—Cracks in the bank or in the area immediately behind top bank
—Overhanging banks
—Undermined trees with exposed roots
—Scour along the bank toe
—Changes in channel bed elevation
—Wave action
—Rapid drawdown



Sample map sketch showing eroded bank toe.



Sample map sketch showing sloughed bank resulting from eroded toe.

—Increased load on the top of the bank

—Higher flood stages than have occurred in past years

—Logs, debris, and sandbars in the channel that could deflect eroding currents into the bank

These types of problems should be recorded during an inspection visit on a dated map sketch of the site. This sketch should show the location of the streambanks (top and toe), eroded areas, vegetation, fence lines, buildings, sandbars, logs, debris, and any streambank protection works already in place. Side views of the bank should also be made at various locations. Be sure to reference all side views to some fixed point such as a tree or fence post. Photographs should be taken (and dated) and the locations from which the photographs are made shown on the sketch. Additional visits should be made on a regular basis, including once during low water season (normally during the summer or fall) and once immediately after any high water period. If the landowner or local government has several miles of streambank to monitor, detailed inspection visits probably cannot be conducted along the entire length of the bank. Those sections of the bank that are particularly susceptible to erosion or failure (see "Signs to look for" above) should be visited regularly, whereas stable banks can be inspected as time allows.

Even if there are no problems observed during a visit to the streambank, a dated map sketch should still be made for future reference. If the day comes that the bank does become distressed, this historic information could provide help in determining the cause of the problem and what measures would be most effective in dealing with the erosion or failure. Hopefully, the solution will be obvious, such as placing concrete rubble at the foot of the bank to prevent erosion due to stream currents. On the other hand, the problem could be more subtle or of a larger extent and will require professional guidance. The sketches and photographs made of the bank over past years will provide the professional engineer or scientist with invaluable information needed to make sound recommendations for protecting the distressed bank.

Streambanks should be photographed to document developing problems and visited regularly to check for signs of bank erosion or failure. Ideally, visits should be conducted by two or more persons, not only for safety reasons, but also for recalling site conditions at a later date.

Another source of historic information is aerial photographic surveys conducted by the U.S. Department of Agriculture (USDA), Agricultural Stabilization and Conservation Service (ASCS). Photographs are made every 6 to 10 years over most agricultural areas. A check should be made with the local ASCS office to determine if photography is available and how it can be ordered. Costs are usually minimal.

Landowners and local governments must decide if bank is worth protecting.

The suggestions made in the preceding paragraphs do not provide much guidance for landowners and local governments who do not have the advantage of historic records but need to identify the cause(s) of streambank erosion or failure. If study of this pamphlet and the existing condition of the bank do not provide the clues needed to determine why the problem developed, then the last recourse is to draw on experience gained through solutions of similar problems that have occurred in the past, possibly on the same stream or in the general area of the distressed bank. Professional assistance will be needed in many cases to extend available past experience to a specific problem.

Step 2

DECIDE IF THE BANK IS WORTH PROTECTING

If examination of a distressed bank condition indicates that the problem is not related to the rise or fall of the streambed elevation (see Streambeds, page 5), and those causes that have placed the bank in a distressed condition can be identified, then the landowner or local government must decide if action should be initiated to protect the bank. Unfortunately, the question is generally not "Should the bank be protected," but instead is "Is the bank worth protecting?" or, turning the question around, "What is the risk if the bank is not protected?"

Consider the following situations:

a. Farmer Brown has 50 acres of bottomland that he occasionally uses for livestock grazing. The stream adjacent to the pasture bottomland has been slowly eroding the bank away for the past 15 years. A local contractor estimates that Brown will have to spend at least $5,000 to protect the bank. Downstream from the erosion site, Farmer Brown is gaining some acreage due to sediment deposition. Although this area is not building up as fast as the upstream pasture is being lost, it is suitable for grazing—should Brown invest $5,000 to protect the eroding bank?

b. Dr. Jones has a home valued at $150,000 on the bank of what is normally a small stream. An unusual number of floods over the past 5 years have eroded the bank to within 50 feet of Jones' home. An engineering firm studied the problem and determined that the flooding is probably caused by accelerated runoff from the parking lot of a large shopping center upstream from Jones' home, although the evidence is not conclusive. Further, the engineers recommend protecting Dr. Jones' bank by constructing several dikes extending into the stream. These structures would deflect eroding currents away from the bank and would slow down the water flow near the bank. As the water slows down, the sediment it carries should be deposited between the dikes and on the eroding bank. If sufficient sediment deposition occurs the dikes will be covered up and the bank restored to its original condition. The only problem with this approach is that the eroding currents deflected away from Dr. Jones' bank by the dikes may cause erosion on the opposite bank. This possibility could bring about legal action. Should Dr. Jones have the dikes built ... consider another approach to protect the bank ... move his home ... abandon the home ... tough decision.

c. Mr. Smith purchased 50 acres of hardwood forest adjacent to a stream for $1,000 per acre. Foresters told Smith that he will have $20,000 to $30,000

worth of marketable timber in 10 years with inflation discounted if his stand does not become diseased which is a common problem in the area. A year after Smith purchased the land, he realized that the streambank had receded 10 feet; at that rate 10 percent of his timber stand would be lost by the time the timber matures. The local Soil Conservation Service District Conservationist tells Smith that he could place a mattress made of used tires on the bank for $10,000 which should control the erosion. So Mr. Smith is faced with investing $10,000 to save 5 acres of land (which will appreciate in value) and $2,000 to $3,000 worth of timber provided the stand does not become diseased ... another tough decision.

d. The city of Pickettville is located on State Road (SR) 32 which parallels the bank of a large waterway. Pickettville's major water and gas mains were placed under SR 32. Several major floods have seriously eroded the bank and now endanger SR 32 and the utility lines for a distance of one-half mile along the bank. During past floods, city, county, and state crews have dumped enough rubble down the bank to save SR 32, but all agree that sooner or later the river will take the road. After several years of discussion the City Council wrote the Corps of Engineers for assistance. The District Engineer authorized a study which indicated that the bank could be stabilized. However, for one-third of the cost of the streambank protection works, SR 32 and the utility lines could be relocated. Further, emergency funds could be made available for this relocation, but sufficient funds were not available for construction of the more expensive bank protection works. The Corps of Engineers report also predicted that the bank could stand only one or two more major floods before SR 32 and the utility lines would be lost. After these losses, no further significant city or private damages would occur within the foreseeable future. The City Council finds that the community is strongly opposed to the proposed relocation because SR 32 would have to be rerouted through the city's park and across the playground of the elementary school. With an election on the horizon, the City Council has reservations about the relocation. On the other hand, if the bank washes out next spring, the Council will be blamed for not proceeding with the Corps of Engineers proposal.

A community or group effort to protect a distressed streambank can often jointly benefit everyone involved.

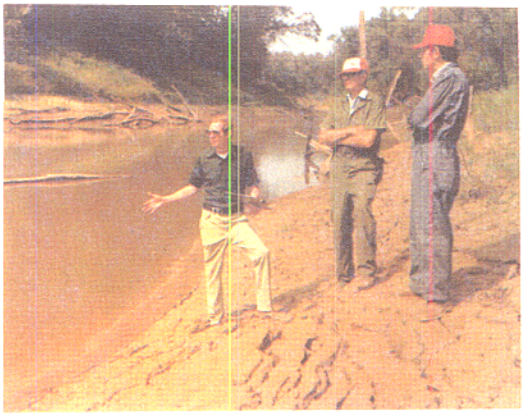
Each decision to determine if a bank is worth protecting is unique. No step-by-step guidelines can be laid out for reaching this decision. Tangible and intangible assets must be weighed against the anticipated costs of proposed solutions and, in some cases, legal and political consequences. Thus, with all of these factors under consideration, the final decision to protect or not protect a bank must ultimately rest with the landowner or local government.

Step 3

INVENTORY AVAILABLE RESOURCES

Once the decision has been made to protect a distressed streambank, an inventory should be conducted to determine what level of group or community cooperation should be expected and to identify available financial, technical, manpower, equipment, and construction material resources. The results of this inventory will determine to a large extent what types of streambank protection works are feasible.

GROUP OR COMMUNITY COOPERATION. Distressed streambanks rarely begin and end at property lines, thus bank



The SCS inspecting a distressed streambank...

...recommendations are made...

...financial assistance may be provided by the ASCS.

erosion or failure problems are, in most cases, group or community problems as opposed to an individual problem. Prior to initiating individual action to protect a streambank, adjacent landowners should be contacted. Possibly a cooperative effort can be organized that would jointly benefit everyone involved. Otherwise, a well planned and properly constructed streambank protection project could be damaged or lost because erosion or failure continues on adjacent property. By pooling resources, a much lower cost per foot of bank protected may result from a group or community effort. In addition the bank may be effectively protected for a longer period of time because the entire length of an eroding or failing bank was protected as opposed to only a portion of the bank...or put another way, construction of a streambank protection project without proper assessment of bank conditions upstream and downstream from an individual property owner's distressed bank may be a commitment to project failure.

Another important advantage of group or community cooperation is legal protection. For example, an improperly aligned streambank protection project could direct stream attack against a downstream neighbor's bank, or the project could present a safety hazard or be considered as an eyesore. If such undesirable consequences can be directly linked to an individual's streambank protection activities, he may be found liable for damages. Group or community agreement regarding the method selected to protect a bank should be reached prior to construction. A legal contract relieving all of the principals involved of any tangible or intangible damages resulting from a streambank protection effort can help to avoid strained relations and legal problems.

FINANCIAL AND TECHNICAL ASSISTANCE. Assistance for landowners and local governments may be available from the U.S. Army Corps of Engineers, the USDA Soil Conservation Service (SCS) and the ASCS, and various state and local agencies. Under present law, the Corps of Engineers cannot provide financial assistance for a streambank protection project aimed solely at protecting private property; however, the Corps of Engineers can participate in the funding of certain kinds of emergency protection work under the authority of Section 14 of the 1946 Flood Control Act (Public Law 79-526). The Corps of Engineers District having jurisdiction over the stream on which the landowner or local government has a bank protection problem should be contacted to determine if funding is available under the authority of Section 14. The addresses and telephone numbers of the Corps of Engineers Districts are listed on page 55; a map is also provided showing district boundaries (page 57).

Another source of assistance is the SCS. The SCS has an office in each state capital and generally a local office in each county (a telephone number is listed in most directories). At a landowner's or local government's request, the SCS will usually inspect a distressed streambank provided the inspection request has been properly coordinated through the local soil and water conservation district. If a problem exists that warrants remedial action, the SCS will make recommendations and assist in developing a plan to correct the problem. Some financial assistance may be available through the ASCS. The funding level is based on an annually determined percentage of the total project cost not to exceed

$3,500. The SCS may assist the landowner in making an application for financial aid through the ASCS if the project is eligible.

The Water Resources Divisions of the U.S. Geological Survey (USGS) in each state are sources of valuable information useful for planning. A variety of geologic and topographic maps is available from the USGS (contact the USGS National Cartographic Information Center at 507 National Center, Reston, VA, 22092, telephone 703-860-6045). They also can furnish data on streamflow and water-surface elevations at many locations (the Corps of Engineers may also have data). Other possible sources of technical information and assistance are state geological surveys and state departments of public works, transportation, and natural resources. Some local agencies may also be of assistance.

MANPOWER, EQUIPMENT, AND CONSTRUCTION MATERIALS. If good group or community cooperation is developed, sound technical advice is provided, and sufficient financial assistance is authorized, then the availability of manpower, equipment, and construction materials may not be important considerations. Unfortunately, these optimum circumstances are rarely realized. A more realistic situation is some technical advice, no financial assistance, and the responsibility for rounding up manpower, equipment, and construction materials being left entirely to the landowner or local government. Thus, the type of streambank protection works to be constructed are, in part, dependent on the resourcefulness and innovation of the builder.

Once manpower, equipment, and construction material resources are inventoried, project planning may be pretty well boxed in; that is, if manpower is limited, then labor intensive streambank protection works are not feasible ... if equipment such as trucks, tractors, and graders are not available, then movement of large amounts of soil and rock will not be possible ... if materials needed to construct the project cannot be economically obtained, then other solutions to the streambank erosion or failure problem must be considered. Obviously the manpower-equipment-construction materials inventory is essential to the success of the project; thus, no stone should be left unturned. Solicit manpower from neighbors, friends, Boy Scouts looking for a community service project, etc. If suitable construction materials are not available, look for substitutes — although quality stone riprap may be desirable for a project, consider substituting broken pavement, concrete blocks, brick, or tile (provided they are heavy enough not to be washed away by the streamflow). If the timber needed to construct a bulkhead is too expensive, consider rounding up used tires from local service stations, and then stacking the tires to form a bulkhead. Landowners and local governments, who are willing to negotiate, substitute, and scrounge, stand a better chance of constructing a successful streambank protection project than a builder who takes the attitude of "we'll make do with what's behind the barn."

Step 4

SELECT A BANK PROTECTION METHOD

The selection of a method to protect a distressed streambank is the key step in the "eight step plan of action." At this point, the landowner or local government has hopefully determined the cause and extent of bank distress, has decided that the bank is worth protecting, and has carefully conducted a resource inventory. The problem and available resources must now be

Equipment and operators can sometimes be secured gratis or for a nominal fee from sympathetic local interests.

matched against a bank protection method that will effectively control further loss of the bank. An improper match may commit the project to failure before construction is ever started.

Prior to making the final selection of a method to protect the bank, every avenue of technical assistance should be explored and all legal ramifications carefully weighed. Consideration should be given to every feasible type of streambank protection. Approaches that have proven to be especially suitable for use by landowners or local governments are discussed on pages 29-48. The text, photographs, and sketches describing these approaches should be studied in detail to appreciate the full range of alternatives. When all possible information is in hand, the selection must be made; once past this point the resources are committed.

Technical advisers will almost always initially recommend that permanent protective works should be built but understand that landowners and local governments cannot always afford the large costs. This means there may have to be departures from standard designs to provide some degree of protection against erosion or failure. These compromises will tend to decrease the initial cost of construction; however, higher maintenance costs and shorter project life are inevitable. The danger is to underdesign the project to cut costs and as a result risk total failure.

Step 5

DEVELOP A PROJECT PLAN

Improper project planning can result in problems during the entire period of construction and beyond. Time invested in detailed planning prior to beginning construction will yield dividends throughout the life of a project. Plans should be laid out in steps; an example of a typical plan is:

- ☐ Prepare drawings of the construction site showing detailed top, front, and side views of the proposed bank protection structure; a technical advisor often handles this job.

Time spent in project planning will yield dividends throughout the life of the project.

- ☐ Arrange for financing the project. Be aware that a good project plan has maintenance possibilities included; thus, future funding requirements should be anticipated during preliminary planning.
- ☐ Draw up and sign any legal contracts needed to protect the landowner(s) or local government.
- ☐ Investigate potential adverse environmental impacts that may result from construction of the project (see comments below).
- ☐ Apply for all permits required for construction.
- ☐ After all required permits are approved, determine when construction can begin and when it should be completed. If there is a lengthy delay between initial planning and construction, project plans should be reviewed to determine if the selected streambank protection method will still be effective.
- ☐ Insure that road access to the site is available.
- ☐ Make arrangements to secure all materials needed for construction and be sure that delivery can be made before the materials are needed at the site; prepare accessible areas at the site where the materials can be stored.
- ☐ Determine that the construction period will be properly coordinated with manpower and equipment commitments, weather conditions, and low water.

Although environmental impacts may not be of immediate interest to a landowner or local government, this important consideration should be included in project planning even if the only motive is maintaining community harmony. Typical examples of projects that would probably be viewed as having adverse environmental impacts are:

a. Automobile bodies placed on a bank across the stream from an exclusive housing area; the homeowners may claim that the bodies are not only an eyesore but will lower the value of their homes. (*The use of automobile bodies is not recommended in any form for streambank protection.*)

b. A used-tire mattress constructed by a farmer on a bank above a sand berm that is used as a beach during low-water periods; bathers may say the mattress denies recreational access to the beach because a mattress is difficult to walk over. The farmer views bathers as trespassers but is not sure where his property line is because the stream has changed its course several times over past years.

c. A set of fences built from a bank toward midstream; although the fences will deflect the current away from the bank and encourage sediment deposition, pleasure boaters may regard the fences as a hazard.

If there is any doubt as to whether a proposed bank protection method may raise a negative reaction, then adjacent landowners or the community should be made aware of project plans well before commitments are firmed up. (This may have already been done as part of Step 3.) If a problem does become apparent, perhaps a modification or alternative to the project plan can be developed such that the adverse impact can be eliminated or minimized and the landowner or local government will get the streambank protection needed.

On the other hand, construction of a streambank protection project could have positive environmental impacts such as reducing the sediment load of a stream by protecting an eroding bank or improving the appearance of a raw bank by grading it off and planting grass. Hopefully, consideration of impacts will be built into the landowner's or local government's project planning process such that the environment is improved because a bank was protected.

Step 6

OBTAIN A PERMIT

A Corps of Engineers permit is usually required if a landowner or local government plans to build a streambank protection project. The Corps of Engineers was assigned the responsibility for issuing permits by the Congress under authority of Section 10 of the River and Harbor Act of 1899 to prevent alteration or obstruction of navigable waterways in the United States.

Water pollution and maintenance of freshwater supplies have become serious problems in the past few years. Responding to this need, the Congress passed legislation requiring permits for the discharge of dredged or fill material into the navigable waters of the United States (Section 404 of the Federal Water Pollution Control Act Amendments of 1972, as amended by the Clean Water Act of 1977). Administration of this permit program was also assigned to the Corps of Engineers. In 1975, the U.S. District Court for the District of Columbia directed the Corps of Engineers to extend its responsibility to regulate the discharge of dredged or fill material under Section 404 to all *Waters of the United States.*

What does this legislation mean to the landowner or local government trying to protect a streambank? The term *Waters of the United States* includes all dry land and water-covered areas below the ordinary high water marks on navigable and non-navigable streams. Thus, any proposed bank protection project requiring soil excavation or fill or a project where a structure is to be built within the zone defined as *Waters of the United States* will probably require a permit.

To reduce the delays that would result from processing a permit for each streambank protection project, the Corps of Engineers has issued a nationwide permit. The

Regulatory Functions Branch of the Corps of Engineers District having jurisdiction over the stream in which a project is to be built should be contacted to determine whether the project is covered by the nationwide permit. (The addresses and telephone numbers of Corps of Engineers Districts are listed on page 55 of this pamphlet; a map is provided on page 57 that can be used to determine in which district a particular project is located.) If the proposed project is covered by this permit, the landowner or local government will be advised in writing and construction can begin. If the project is not covered by the nationwide permit, the Regulatory Functions Branch will advise the permit applicant that he must apply for either a regional or individual permit.

Regional permits are similar to the nationwide permit but are limited to specific areas. The Regulatory Functions Branch may or may not require that the landowner or local government supply information related to the proposed project before construction is authorized under a regional permit. In either case the Regulatory Functions Branch will advise the applicant in writing whether the proposed project is covered by this type of permit.

If the proposed project requires an individual permit, an application on Engineer Form 4345 must be submitted (see pages 58 and 59). Form 4345 can be obtained from the Regulatory Functions Branch along with pamphlet EP 1145-2-1, *U.S. Army Corps of Engineers Permit Program, A Guide for Applicants*, which describes the application procedure for an individual permit. The form should be filled out completely and accurately and submitted to the Regulatory Functions Branch along with a map showing the location of the project and a good quality, easily reproducible drawing showing the important features of the method proposed to protect the streambank (see page 60). Each application is then evaluated to determine the probable impact that the project will have on the public interest. During the evaluation, a public notice is prepared and circulated for comment to the Environmental Protection Agency, the U.S. Fish and Wildlife Service, and other appropriate Federal and state agencies and interested individuals. If there are no objections, a permit will be issued in writing usually within 60 days after a completed application is received.

Objections to the project that are received in response to the public notice will be discussed with the applicant by personnel of the Regulatory Functions Branch. Possibly, the proposed design may only have to be slightly modified to eliminate the objectionable feature. On the other hand, a completely new design may be needed. Regardless, an applicant should never begin work that requires a Federal permit before official authorization is received.

All states require a water quality certification stating that a proposed project will not violate the water quality standards of that state. The Regulatory Functions Branch can advise the landowner or local government as to which state agencies should be contacted for the water quality certification or for other certifications that are required.

Step 7

CONSTRUCT THE PROJECT

When all required permits are approved construction may begin. If the landowner or local government is handling the construction, then timeliness, efficiency, and safety are the keywords — timeliness in constructing the project when the water is low and the bank is dry; efficiency in arranging for the availability of materials, equipment, and manpower to reduce any loss of working time; and proper safety considerations to minimize the chance of accidents.

Several common sense safety precautions should be followed:

- Safe access and working conditions must be maintained in the construction area.
- Someone trained in first aid techniques should be on site during all phases of

construction; an adequate stock of first aid supplies should be available.

- All workmen should be physically able to undertake the effort required. No one should take unnecessary risks such as working in or near deep water without a life preserver.
- Protective clothing, such as safety shoes, gloves, goggles, and hard hats should be worn by all workmen during any type of activity requiring protection.
- Construction materials should be stored in an orderly manner on a solid, level surface.
- Waste materials should be removed from the work area regularly and disposed of properly.

If a contractor will be hired to construct the project, competitive bids should be taken to insure obtaining quality work at the lowest price. Another factor to consider in selecting a contractor other than cost is experience. If the contractor has not previously constructed streambank protection works, he may have difficulty completing the project because of inexperience or underestimating the job. When a landowner or local government enters into an agreement with a contractor, the contract should clearly state the responsibilities of both owner and contractor. The contract should indicate exactly what will be built, how much material will be used, the beginning and ending dates of the construction period, and cost.

Site access is an essential element of preconstruction preparation.

ABOVE: An application for a Corps permit to build a streambank protection project must be submitted and approved before construction can begin.

BELOW: Local landowners begin construction of a used-tire revetment.

Step 8

INSPECT AND MAINTAIN THE PROJECT

A streambank protection project will generally require some maintenance if the project is expected to protect the bank on a long-term basis. Periodic inspections should begin soon after construction is completed. Early detection and proper maintenance of a developing problem will not only avoid needless expense and property loss but could also eliminate a potential safety hazard.

ABOVE: Landowners and local government officials should periodically inspect completed projects to determine if any maintenance is needed.

Surface erosion can be monitored by placing a row of treated wooden stakes from the toe to the top of a bank.

RIGHT: A plumbed rod driven at least 8 feet into a bank can be used to determine if bank movement is occurring.

Each inspection or maintenance activity should be well documented with dated photographs and sketches. For example, a gradual loss of vegetation or stone riprap may not be readily apparent during an inspection visit; however, comparison of photographs or sketches made over several visits may indicate that a problem is slowly developing.

Streambank surface erosion can be monitored by placing a row of treated wooden stakes (or metal rods) from the toe to the top of the bank. This simple method can be implemented by first driving stakes at the toe and top of the bank and drawing a taut string line between the stakes. Other stakes are then driven at regular intervals along the line. After the stakes are in place the bank should be visited frequently to determine if the bank is eroding around the stakes or if one or more of the stakes are missing entirely; either condition would indicate that active bank erosion is in progress.

A plumbed rod driven at least 8 feet into a bank can be used to determine if the bank is unstable. The rod should be plumbed with a carpenter's level as the rod is driven into the bank. If future checks indicate that the rod is tilting out of plumb, then bank movement is occurring which may signal that problems are ahead.

Once a need for maintenance is identified, more frequent inspection visits should be made until the necessary steps can be taken to correct the problem. If no maintenance of the streambank protection works is required or anticipated, then an inspection during the summer or fall low-water season and after each high-water period is probably sufficient to ensure that no serious problems develop without the knowledge of the landowner or local government.

Two Case Histories

EXAMPLE 1. By carefully following Steps 1-8 of the Plan of Action suggested above, a streambank protection project will have a better chance of effectively doing the job that it was designed to do as opposed to the builder taking a "hit or miss" approach and hoping for the best. As an example of the need for a well-developed plan of action, consider Farmer Green, who has property fronting an eroding bank. Green inspects his bank and finds erosion occurring in several areas. Not bothering to talk with his neighbors about the problem or seeking technical or financial assistance, Green decides to protect the eroding streambank with automobile bodies that he can purchase locally at a nominal price. During the summer, Farmer Green randomly dumps bodies on the eroding banks without chaining the bodies together or attempting to tie them into the bank. The scene is now set for a real problem. During the next spring, record rainfall over the upstream watershed causes flash flooding. The automobile bodies are scattered for several miles downstream along the bank and in overbank areas. Many of the bodies collide with bridge piers and docks as they drift downstream. As a result, Green is sued for damages by both landowners and the county government. In addition, the Regulatory Functions Branch of the Corps of Engineers District having jurisdiction over the waterway in which Green dumped the bodies, informs him that he is in violation of Federal laws having fines up to $25,000 per day of violation and imprisonment up to one year; also, he may be in violation of state water pollution laws. Clearly, Green's approach to bank protection was not properly planned.

EXAMPLE 2. Consider the same situation as described above except that Farmer Green follows this pamphlet's plan of action. After studying Understanding Streambank Erosion and Failure, page 7, he concludes that his bank erosion problem is due to passing stream currents during flood flow. After some consideration, he decides that he will try to save the bank by following the suggested plan of action as closely as possible. He discusses the problem with his upstream and downstream neighbors who have similar conditions along their property fronting the stream. Collectively, they decide to contact the county's SCS office and request that the district conservationist inspect the eroding banks. The conservationist determines that there are ten eroding sections fronting the bankline of the landowners, five of which should be considered as serious and five not so serious. In four of the seriously eroded areas the conservationist suggests dumping concrete rubble that may be available from a nearby highway construction project. At the fifth seriously eroding area, the bank is rapidly failing on one side of the stream while a point bar is building up on the other bank. The net result is a continuing exchange of productive farmland for a nonproductive sandbar. The conservationist recommends construction of several post and wire fence dikes extending from the existing eroding bank into midstream. These structures will encourage sediment deposition (and build up the eroding bank) while forcing the current against the sandbar. This type of fencing could easily be erected during a low-water period using group manpower and available farm equipment. Finally, he recommends planting willows along the less seriously eroded banks. The conservationist also helps the landowners apply for financial assistance from the ASCS and to secure a sufficient number of rooted willows to plant on the five less seriously eroded banks. The conservationist also arranges to obtain a limited number of a superior willow selection from an SCS Plant Materials Center for evaluation on one of the eroded banks.

After contacting the State Highway Department through a state legislator, the landowners are advised that the concrete rubble is available at no cost. The highway construction contractor agrees to break the pavement up into pieces small enough so that the rubble can be handled with a front-end loader. The County Highway Department agrees to remove the rubble from the construction right-of-way and to dump the material on the four seriously eroding banks providing the landowners will provide the necessary access. The ASCS advises the

group that $1,000 can be made available for construction of the fence dikes.

At this point, the equipment and resources needed to construct the project are in place. Farmer Green and his neighbors and the SCS conservationist then develop a project plan that includes the following major work items:

- Prepare a legal agreement to be signed by the landowners releasing them from apparent damages to each other's property as a result of the streambank protection project.
- Draw up diagrams and maps showing how the bank will be protected at each of the ten locations.
- Lay out access routes to the five seriously eroding banks.
- Collectively agree to provide the manpower necessary to construct the fence and plant the willow shoots as soon as possible after the spring high water has gone down.
- Request that the County Highway Department dump the rubble as soon as access routes can be made available.

After the project plan is completed, the landowners in consultation with the SCS conservationist determine that no apparent adverse environmental impacts will result because of the proposed construction. The next step is to contact the Regulatory Functions Branch of the Corps of Engineers District in which the project is to be constructed. The Regulatory Functions Branch provides the landowners with Engineer Form 4345 (Permit Application), pamphlet EP 1144-2-1, and information on how to apply for water quality certification from the State Pollution Control Agency. The landowners complete and submit Form 4345 and the state form for a water quality certification; 60 days later both the approved permit and water quality certification have been received and construction can proceed. After the project is completed Farmer Green and his neighbors agree to periodically inspect the parts of the project fronting their property and to report any problems to the other landowners.

CONCLUSION. The two examples discussed above probably represent the extremes in landowner and local government streambank protection projects — one project where nothing was done right and the other where the project was well-planned and there were no problems with resources or permits — a model project. The majority of projects will fall somewhere in between these two extremes; however, all efforts should be initiated with the goal of constructing a model project.